ROLLING CONVEYING DEVICE

The invention is related to the field of materials handling technology and concerns a conveying device for the conveying of materials, objects and so on, wherein this device is capable of being equipped with any means for taking on materials or objects. The invention is distinguished by the fact, that with few, inexpensive means any conveying paths or conveying tracks are capable of being created, on which it is possible for a flowing conveyance to take place.

The invention essentially consists of few components, namely: of one or two guide rails, in which a rolling body or a combination of rollers with a plurality of freely rotating rollers, balls, cylinders, etc. is arranged and with a plurality of conveying bodies capable of being displaced on or between the rollers of the rolling body. The rolling bodies form, for example, circuits closed in themselves, however, they are not chains, because unlike those they are not pulled or pushed.

Figure 1A and **1B** in an exploded view illustrate a piece, resp, part of a track of an exemplary conveying device in accordance with the invention. In this example, one of the guide rails 6 comprises an engagement groove or guide groove 7, in which the rollers 2 of the rolling body 1 are able to rotate freely. The rolling body as a combination of rollers consists of a connecting piece 4, on which a plurality of rollers 2 are arranged freely rotatable on axes 3. The same arrangement of guide rail 6' and rolling body 1' with rollers 2 is present again in mirror image as a counterpart. In between one is able to see two (out of a plurality) of conveying bodies 10, which on

both sides longitudinally comprise an engagement groove or guide groove 11 for the free and undriven running of the rollers 2, in order to get into an operational connection with the roller bodies 1 and 1' and the rails 6 and 6', the latter of which in this depicted embodiment extends from rail 6 to rail 6' and enables a rolling displacement of the conveying bodies 10. The rollers 2 engage in the corresponding guide groove 7 and 11 by up to between 1/5 to 1/3 of the diameters of the rollers utilised. The conveying body 10, schematically illustrated, comprises a receptacle 12 for the attachment of, for example, a clamp for materials to be transported. Not illustrated are: one drive, resp., several drives, with which the conveying bodies 10 are moved, resp., driven. A connecting plate 5, by means of which the two guide rails 6 and 6' are held together and at the same distance from one another, is indicated below them. As stated, all Figures only illustrate a part of a conveying track of any length and with any routing. Variants of it are discussed following the captions of the Figures.

The rolling body 1, resp. 1' and in a further embodiment of the device the rolling body 8 (refer to Figs. A and B) is capable of being designed in the following manner: the connecting piece 4 is manufactured out of an elastic material, in which the axes 3 for the rollers 2 are fixed. The axes 3 comprise a seat (not depicted here), which prevents the rollers 2 from coming into contact with the connecting piece 4, in other words, which enables the rollers 2 to be freely rotatable. The rollers 2 are put on to the axes 3 and at the upper end of the axes 3 are fixed so as to be adequately prevented from becoming detached from them. In this embodiment, it is possible for the roller bodies to adapt themselves to any track shape of the guide rails 6, 6'. Capable of being utilised as materials for the connecting piece 4, for example, are plastic bands (ribbons), for the rollers 2 a rigid plastic material and for the axes 3 metal pins are usable materials.

The conveying bodies 10 are able to be manufactured out of the same material as the rollers 2. These conveying bodies are jointly driven, wherein one pushes the other

one. For a drive of this kind, it is possible to provide an engagement from below through the connecting plate 5 or laterally on the receptacle 12, for example, by means of several conveyor drives arranged at a distance from one another.

An essential point is that the engagement of the rollers 2 in the guide grooves 11 may comprise a relatively large play, without the operability being impaired by this. This provides the possibility during the manufacturing of producing components for the device in large numbers without the necessity of a great precision, which in turn has a very beneficial effect on the cost side. And despite this, for a mechanical construction, relatively loose assembly the conveying bodies run in a silkily soft and almost flowing manner, so that it is possible to refer to a kind of flowing materials handling technology.

In the following, the object of the invention discussed above is described in more detail on the basis of preferred examples of embodiments, which are illustrated in the attached drawings. These depict:

Figures 1A and 1B the embodiment of the invention described above,

Figures 2A and 2B a part of an embodiment with three rolling bodies for guiding the conveying bodies,

Figures 3A 3B and 3C a part of a further embodiment with a stylised drive for moving the conveying bodies,

Figures 4A 4B and 4C an embodiment with a combination of rollers of balls instead of rollers,

Figures 5A 5B and 5C an embodiment with a stylised drive for the conveying bodies,

Figure 6 another embodiment with a stylised drive for the conveying bodies.

Figures 7A 7B und 7C a row of conveying bodies in a three-dimensional curve,

Figure 8 conveying bodies with a special form of link joints between one another,

Figures 9A and 9B the conveying device according to the invention as a closed track,

Figures 10A and 10B an embodiment of the rolling body, which is especially suitable for tight curve radii,

Figures 11A and 11B this embodiment of the rolling body depicted with inserted roller bodies and one of the two guide rails,

Figures 11C and 11D one element of the rolling body with inserted balls and a guide body illustrated in a frontal view and in a perspective view,

Figures 12A and 12B and 12C a further embodiment of the three elements, a guide body, which comprises both guide rails, therefore guide rail, rolling body and conveying body, in the case of which one guide rail is also capable of taking over the function of the second guide rail,

Figures 13A and 13B and 13C an embodiment of the imitation of the embodiment in accordance with Figure 4, in the case of which the rolling bodies are also capable of consisting of roller bodies without any mutual connection.

The reference marks utilised in the drawings and their significance are listed in summary in the list of reference marks. In general, in the Figures identical components or analogous components acting in the same manner are provided with the same reference marks.

In this context, the following is to be remarked: the illustrations are in the form of rough sketches and not finished constructions and all physical depictions are parts of a whole. It is possible that the whole respectively is a track closed in itself, in which the rolling bodies, the rows of conveying bodies and the guide rails respectively lead back to themselves.

The **Figures 2A** and **2B** in an exploded drawing illustrate a part of a different embodiment of the rolling conveying device. In addition to the embodiment depicted in the Figures 1A und 1B, a third rolling body 8 (exceptionally not designated with 1, but advantageously of the same manufacture as the rolling body 1) is arranged underneath the conveying bodies 10, the position of which is easily seen in the frontal view in accordance to Figure 2B. The conveying bodies 10 for guiding the rollers 2 of the conveying body 8 comprise an engagement groove or guide groove 11'. Equally the modified connecting plate 5' comprises an engagement groove or guide groove 7', in analogy the guide rails. It is possible that the depth of the guide groove 11' in the conveying bodies 10 amounts to less than 1/5 of the diameter of the rollers utilised. It is also conceivable that one completely makes do without them (the guide grooves) on the conveying bodies and that the rollers 2 only serve to support a load. This embodiment, for example, is suitable for heavy loads, in the case of which the additional rolling body 8 is capable of taking over a significant part of the load. In addition, the designing of the rollers 2, resp., of the rolling body 8 as a combination of rollers is able to be implemented especially for greater loads. The same is applicable for the guide rails 6, 6', 5.

This embodiment, for example, is suitable for a contour-oriented conveyance, that is, over several levels, of articles such as packages in postal distribution centres or of travellers' baggage at airports. The flowing, non-jolting, not awkward and as continuous as possible conveyance by means of an inexpensive installation is always a requirement of the market, which is easy to fulfil with a device of this kind in accordance with the invention.

The **Figures 3A, 3B** and **3C** in an exploded view illustrate a part of a further embodiment. The conveying body 10 is designed in the shape of a kind of prism with essentially 60 degree angles. The two rolling bodies 1 and 1' are arranged orthogonally to the surface of the conveying body, so that they themselves are inclined towards one another (in essence they form a 120 degree angle). At the ‚tip' between the rollers 2 a receptacle 12 for the attachment of a means, for example, a clamp, a hook or something similar is arranged. In the oppositely situated flat side a conveying toothing 9 is to be seen and above it, stylised, a drive unit 20 with a drive motor 19, which through a shaft 18 is capable of driving a star-shaped drive wheel 16 here in both directions of rotation, refer to the double arrow. In the case of longer conveying stretches, drive units 20 of this kind are arranged distributed over the complete rolling conveying device. It is more advantageous to provide several drive units distributed over the conveying stretch than a single one. Thus a ‚distribution of gaps' is to be expected instead of a single large gap immediately behind the single drive. In this context, it of course has to be observed that every drive unit has to provide the same conveying speed for the system, which with current means for controlling motors does not represent a problem.

This embodiment is suitable, for example, for being arranged at the ceiling of a room. Figure 3C illustrates an attachment to a ceiling 15, which, for example, may also have the appearance of a U bent together at the legs and which on its upper side comprises fixing holes 14, through which it is able to be attached to the ceiling. In the region of the guide rails one is able to see fixing screws, by means of which the

ceiling attachment is connected with the guide rails. Attachments of this kind, as is illustrated in the Figure, are also capable of being directly combined with a drive. It is also possible that an embodiment of this kind of suspension and drive is arranged distributed over the whole conveying stretch.

The Figures 3A, 3B, 3C in a stylised form each respectively illustrate a part of the rolling conveying device with only a single conveying body of many, and respectively in detail the rolling bodies 1,1' and the guide rails 6,6' and a drive 20 with a cover 15, which latter element is conceived as a suspension device and which is capable of being arranged at a distance between one another along the whole conveying track.

The **Figures 4A** and **4B** and **4C** illustrate a further embodiment, in which as the combination of rollers instead of rollers balls 2' (in analogy to the rollers 2) are utilised. In the Figures 4A and 4B the conveying bodies 10 are drawn somewhat pulled apart, in order that it is possible to see the balls through the gap produced. In assembled form the conveying bodies pushing one another do not have a significant gap; the gap between the guide rails 6 and 6' and the conveying bodies 10 amounts to approximately 1/3 of the diameter of the balls utilised. The guide grooves 7, 11 are of course adapted to the ball shape. Furthermore, (Fig. 4A) on the roller bodies 1, 1' one is able to identify the connecting bodies 4 for receiving the balls 2'.

The **Figures 5A, 5B** and **5C** illustrate a stylised depiction of a possible drive 20 for the specific displacement of the conveying bodies 10, on which manipulators for the product not illustrated here, for example, grippers for flat objects are able to be attached. A here star-shaped drive wheel 16 guided within a fixing block 17, which engages at the bottom side of the conveying bodies 10 (as an example, refer to the conveyor toothing 9 in Figure 3A and in Figure 5C), is driven by a drive motor 19 through a drive shaft 18. It goes without saying, that also other types of engagement between the drive and the driven parts are conceivable, such as, for example,

toothings as are utilised for gearwheels. The drive is controlled as required. It is, if so required, possible that it drives in two directions of rotation, refer to the double arrow, so that the conveying bodies 10 in the Figure are capable of being displaced to the left or to the right. The conveyance of the whole plurality formed by the conveying bodies 10, in the closed in itself track, is considered to be the drive in the conveying device. Individual drive units 20 are capable of being attached at different points, at which depending on the length of the conveying track a further drive is required, this also in the context of the ‚gap distribution' already mentioned above.

Figure 6 illustrates a stylised depiction of a further possible drive 20 for the specific displacement of the conveying bodies, on which it is possible to attach manipulators for the product, for example, grippers. A here sector-shaped drive wheel 16', in analogy to the star-shaped drive wheel 16, is driven through a drive shaft 18 by a drive motor 19, for example, a stepping motor. To be seen here is a stylised holding device, here a fixing block 17 for the drive shaft 18. The drive angle of the drive wheel 16' is adjusted as required and depending on the situation. It may amount to 360 angular degrees or also to only a part of this and this as per requirement in two directions (refer to the double arrow), so that the conveying bodies 10 in the Figure are able to be displaced to the left or to the right, also, however, only in parts, if, for example, an accurate positioning during standstill is necessary. This concerns the conveying respectively of all conveying bodies together simultaneously.

The **Figures 7A, 7B** and **7C** one the one hand as an example depict a form of 4 conveying bodies 10 out of the plurality of all and on the other hand a placing together of these in such a manner, that, for example, they are capable of being conveyed in engagement with one another in a slight curve of a track bent in two directions 9 (sideways and upwards). The conveying bodies 10 comprise a stylised receptacle 12 for the attachment of a means, to which, for example, it is possible to attach manipulators. Also visible are the guide grooves 11 for the engagement of the rollers 2 of the roller bodies 1 and 1'. Because the conveying bodies 10, when they

are not coupled together, are always pushed and not pulled, it is advantageous through the shaping of the contact points between two conveying bodies by slanting faces 21 at a certain angle W to the external edge, to provide these with the characteristics of a movable extended conveying body. Figure 7C illustrates the frontal view of the row, the tumbling motion of the conveying bodies on their track, which is bent in two directions, is well visible here.

Figure 8 illustrates another example of an embodiment, similar as in the Figures 7A, 7B, 7C, however, for smaller radii in the conveying tracks. A fourth conveying body is depicted at a greater distance from the others, in order to make the shaping more visible in the zone, in which the conveying bodies are in contact with one another. The slanting faces 21 comprise a greater angle W to the longitudinal edge of the conveying body than in the case of the Figures 7 A, B, C. As a further embodiment, three conveying bodies 10 as an example for all conveying bodies 10 of a device are joined together through a connecting means 13, for example, an elastic connection. This makes the assembly easier and also the manipulation in case of a possible overhaul, one does not have to put individual components together to form a track, which have to be inserted between the roller bodies in a certain direction to one another. It is possible that the guide bodies are also supported on all sides, for example, as a ball shell or mutually, as illustrated in the Figure, in order to be capable of absorbing forces.

The **Figures 9A** and **9B** illustrate an example of a closed in itself track. As already pointed out above, the components guide rails 6, 6‘ and roller bodies 2, 2‘ and conveying bodies 10 lead back to themselves as a closed track and therefore form a closed track, which may be spatially arranged in any way required. In Figure 9A this, for example, is a ring-shaped track, which cut open at one point comprises a gap L, in order to depict, as in the detailed Figure 9B, the here also stylised components guide rails 6, 6‘, roller bodies with rollers 2 and conveying bodies 10 with the

receptacle 12 of a means of attachment. These parts are visible enlarged in the detailed drawing 9B.

The **Figures 10A** and **10B** illustrate an embodiment, in the case of which the rolling bodies 1, 1' (here only with one receptacle 22 or opening for the roller bodies) and the connecting pieces 4 form a unit and these are connected to one another through a connecting body 4, resp., by means of a connecting means 4'. This embodiment is particularly suitable for a conveyance around curves with small radii. Figure 10A depicts a curvature in a first curvature direction and Figure 10B a (rotated by 90 degrees) second curvature direction. Evident from this is also a further curvature direction 180 degrees opposite to Figure 10A and corresponding to Figure 10B. Therefore with this embodiment it is possible not only to convey on tracks bent with curves, but also on spiral-shaped tracks.

The connecting piece 4 and rolling body 1, 1' form a unit; each individual part in these Figures comprises two receptacles 22 for receiving, resp., for respectively building-in a roller body, namely rollers 2, balls 2', cylinders 2", etc., wherein a plurality of roller bodies arranged in this manner each respectively form a first and a second rolling body 1, resp., 1'. A plurality of components of this kind are connected together by means of a connecting piece 4'; it is also possible that they are connected together in an articulated manner. The distance between the units, which may be selected in accordance with the application concerned, has a direct influence on the curve radius to be mastered. In Figure 10B it is easily visible, that in the case of this ‚bend' the distances are able to be short and in Figure 10A one sees, that these distances are limited by the structural shape of the conveying body, This all the more so, when the rolling bodies 1, 1' connected through the connecting body 4 are brought to be bent rotated by 180 degrees to Figure 10A.

The **Figures 11A** and **11B** illustrate the just discussed embodiment with roller bodies in the form of balls 2' and in addition with one 6 of the two guide rails 6, 6'. Figure

11A depicts the curve from above, wherein in the operable condition the balls of course engage in the guide groove 7. From a different perspective in Figure 11B one, however, because of the perspective distortion one does not anymore see all the balls 2' of the roller bodies 1, 1'. But this depiction is suitable for demonstrating, how it is possible to put together a conveying device of this type.

The **Figures 11C** and **11D** illustrate an element or a part of the rolling body / the roller bodies 1, 1' with inserted balls 2' as roller bodies and with a conveying body 10 depicted in a simple manner arranged in between them.

Figure 12A illustrates a rolling body 1, resp., 1' with roller bodies, here rollers 2 or cylinders 2", (also balls 2' are able to be utilised), in the case of which the roller axis has been replaced by two opposing pointed cones 24. These roller bodies are brought into a connecting body 4, which comprises receptacles 22 for all kinds of roller bodies, rollers, balls, cylinders, etc. This rolling body 1 preferably is designed to be elastic, not, however, flexible, so that it is capable of running around curve radii in a bendable manner, depicted with double arrows in different directions, but nonetheless is sufficiently rigid, in order that the inserted rollers 2 or cylinders 2" have a secure grip. A rolling body of this kind is capable of being manufactured in any length; it is also possible that it comprises standardised lengths and that it is arranged in sections between conveying bodies 10 and guide rails 6, 6'. In the following, an interesting application of a rolling body of this kind will be discussed.

The **Figures 12B** and **12C** now illustrate from two perspectives a utilisation of the rolling body in accordance with Figure 12A. One sees a guide body 26, which comprises two guide rails 6 and 6'. The guide rails 6,6' are curved and here implemented in one piece, in other words, the guide body 26 is designed in such a manner, that on one side the one and on the other side the other guide for the conveying bodies and rolling bodies are arranged or moulded. The conveying bodies 10 in correspondence with this one-piece design comprise a guide groove 11 for

rolling off the roller bodies 2" of the rolling body 1 on the one side of the guide rail, namely the part 6 and, stylistically depicted, on the other side, therefore opposite, rollers 2, which may also be fixed rollers (sliders), which run along the guide rail, namely the part 6'. This compact embodiment is particularly suitable, when for reasons of space, for example, in passages through walls or along walls or transitions between floor levels or in case of a spiral-shaped course of the track, a volume as small as possible is permitted. For greater loads one weighs down the conveying bodies 10 in such a manner, that they are seated on the rolling body 1 and for smaller loads it is possible to select the suspended operation, in which they move along the guide rail 6' together with the rolling body 1'.

Both Figures depict three conveying bodies 10 in different positions. A first conveying body is in engagement with the guide rail 6 on the one side and with the guide rail 6' on the other side. Between the guide groove 11 of the conveying body 10 and the guide groove 7 of the guide rail 6, the rolling body 1, of which a part only is depicted, is slid in; on the other side there is the rolling body 1', split-up over the rolling bodies, with rollers 2 in engagement with the guide rail 6'. The space for the rolling body 1 is easily visible in Figure 12B. A second conveying body is not in engagement with the guide rail, the rolling body 1, however, is located close to the guide groove 11, which is easily visible in Figure 12C. A third conveying body is depicted without engagement above the guide rail 6, so that it is easy to recognise its construction. This type of depiction was selected in order to on the one hand be in a position to illustrate clearly the engagement of the components into one another and on the other hand the components themselves. In goes without saying that in case of an installation the length of the track with the roller bodies and any number of conveying bodies is dimensioned in a manner to suit the requirements.

The **Figures 13A, 13B** and **13C** illustrate a further embodiment, in the case of which the rolling bodies 1, 1' consist of a plurality of roller bodies, which are not connected together, here balls 2' within a spacer cage 27 (with receptacles for roller bodies 22),

which are arranged in such a manner, that they are close together and located between the conveying body 10 and the guide rail 6. This embodiment follows the embodiment of 4, but manifests a particularity, which plays a role in case of curves in the track. The roller bodies, here balls 2', are arranged to be rotatable in the spacer cage 27 and the ring-shaped receptacle 22 for roller bodies. The spacer cage 27 serves not only for receiving the balls 2', it also serves as a spacer between the guide rails and the conveying bodies, which Figure 13A clearly depicts. Figure 13B is the frontal view of Figure 13A and illustrates the conveying body 10 with guide grooves 11, which through a special construction between the balls 2' and groove comprise a play in such a manner, that the conveying body 10 is capable of being displaced in the direction of the double arrow D transverse to the guide grooves 7, 7' of the guide rails 6, 6' (guide rail 6' not depicted), which is depicted in the form of a slight dislocation of the conveying body 10 out of its longitudinal axis. In case of a curve of the guide rails, here upwards or downwards, the rigid conveying bodies 10 extending over two balls 2' are capable of so to say tilting over the track radius, which is illustrated in Figure 13C with a double arrow D. Figure 13C in a perspective view illustrates the arrangement in principle, wherein on the opposite side of the guide rail 6 in addition a ball element 2' of the rolling body 1' of an equal plurality is depicted, to which then the second, not illustrated, guide rail 6' is able to adjoin.

In general, it is possible to summarise the invention as follows. A conveying device comprises at least one conveying body 10 as well as rolling bodies 1, 1' in operational interaction with it with a plurality, at least, however, with two rolling bodies such as rollers 2, balls 2', cylinders 2", etc., which rolling bodies 1, 1' are arranged on guide rails 6, 6', 5 and the at least one conveying body in such a manner, that the roller bodies 2, 2', 2" during the displacement of the at least one conveying body 10 are able to rotate freely. The rolling bodies 1, 1' form a combination of rollers, which, for example, is capable of comprising rollers 2 and/or balls 2' or cylinders 2", etc. It is possible that the device comprises one or several rolling bodies 1, 1'. Two rolling bodies 1, 1' are able to be located opposite one another at a

straight angle relative to the conveying body 10. It is also possible that this angle is not straight. A third rolling body 8 may be arranged relative to two rolling bodies 1, 1' in such a manner, that it is capable of absorbing additional load force. The conveying bodies 10 as a rule are driven, not, however, the rolling bodies 1, 1', 8. The combination of rollers serves as a rolling support for the conveyed conveying bodies 10 and is arranged between these and the guide rails 6, 6', 5. To the conveying bodies 10 different types of means for the transportation of the conveyed goods are capable of being attached. It is also possible that they are connected together in a chain-like manner.

The three sub-assemblies guide rail, rolling body and conveying body are respectively designed in accordance with the application in question. If one considers the absolute mutual speeds together, then the following is applicable:

$$V_{\text{Guide rail}} = 0 \quad \text{and}$$

$$V_{\text{Rolling body}} < V_{\text{Conveying body}}$$

and they are connected together in a positive interlocking manner, but guided loosely to one another, which on the one hand has the effect of making the manufacturing costs lower and on the other hand reduces the wear.

LIST OF REFERENCE MARKS

1	First rolling body, 1' second rolling body
2	Rollers
3	Roller axes
4	Connecting bodies
4'	Connection means for the rolling bodies
5	Connection plate / floor plate
5'	Third engagement groove, resp., guide groove
6	First guide rail, 6' second guide rail
7	First engagement groove, resp., guide groove, 7' second engagement groove, resp., guide groove
8	Third rolling body
9	Conveying toothing
10	Driven conveying bodies
11	Engagement groove, resp., guide groove on the conveying body
12	Receptacle for the attachment of a means
13	Connection means for the conveying bodies
14	Attachment holes
15	Ceiling attachment
16	Drive wheel for the conveying bodies
17	Fixing block
18	Drive shaft
19	Drive motor
20	Drive unit
21	Slanted face on the conveying body
22	Receptacle for roller bodies

23	Attachment
24	Cone
25	Ball cage
26	Guide body
27	Spacer cage